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(54) Method and apparatus for providing network protection at input/output interfaces of a cross-connect switch

(57) A telecommunications system (10) includes a first cross-connect switch (12) and a second cross-connect switch (14). The first cross-connect switch (12) includes a switching matrix that provides information from a matrix connection to a selector (28) of an output interface (18). The selector (28) places the information from the switching matrix onto one or both of a working channel (24) and a protection channel (26). The second cross-connect switch (14) receives the working channel (24) and the protection channel (26) at an input interface (20). The input interface (20) includes a selector (30)

that checks a signal quality of the working channel (24) and the protection channel (26). When necessary, the selector (30) sends a request to the selector (28) to bridge the working channel (24) onto the protection channel (26). According to the signal quality, the selector (30) selects one of the working channel (24) and the protection channel (26) for transfer to a switching matrix (22) of the second cross-connect switch (14). The selector (30) avoids creating and deleting matrix connections in the switching matrix (22) in performing protection switches between the working channel (24) and the protection channel (26).

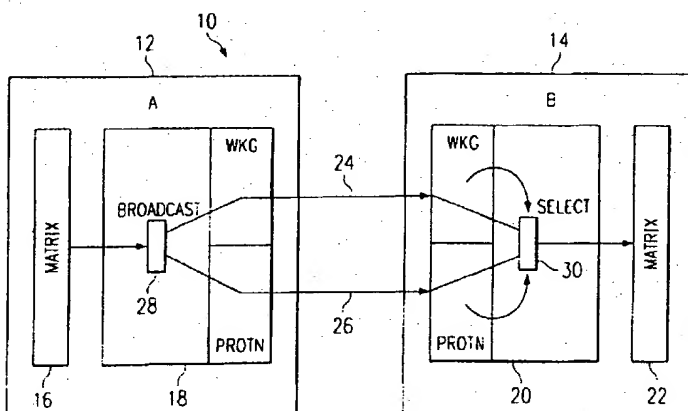


FIG. 1

## Descripti n

### TECHNICAL FIELD OF THE INVENTION

[0001] The present invention is related in general to telecommunications signal transport and more particularly to a method and apparatus for providing network protection at input/output interfaces of a cross-connect switch.

### BACKGROUND OF THE INVENTION

[0002] When network protection is implemented in a cross-connect switch, there are stringent requirements concerning the amount of time needed to perform the protection switch once a problem has been detected. Typically, the protection switch is performed by cutting another connection through the matrix of the cross-connect switch. However, cutting another connection through the matrix has various disadvantages. Cross-connection algorithms generally take more time to complete than is allowed by the protection switching requirements. For example, the protection switching requirements specify tens of milliseconds rather than the hundreds of milliseconds it takes to cut a new connection. Creating and deleting cross-connections may not meet the desired switching times. If center stage rearrangements are required in a standard three stage non-blocking matrix, then the time needed to adjust matrix connections for a protection switch may take even longer. Therefore, it is desirable to avoid the slower than required changes in matrix connections to perform a protection switch in a cross-connect switch.

### SUMMARY OF THE INVENTION

[0003] From the foregoing, it may be appreciated by those skilled in the art that a need has arisen for a technique to perform protection switching that does not require changing connections in the matrix of a cross-connect switch. In accordance with the present invention, a method and apparatus for providing network protection at input/output interfaces of a cross-connect switch are provided that substantially eliminate or reduce disadvantages and problems associated with conventional protection switching techniques.

[0004] According to an embodiment of the present invention, there is provided a method for providing network protection at input/output interfaces of a cross-connect switch that includes receiving an inbound working channel and an inbound protection channel at an input interface. A signal quality of the inbound working and protection channels is determined. One of the inbound working and protection channels is selected in response to the signal quality of the inbound working and protection channels. The selected one of the inbound working and protection channels is provided to a switching matrix. Thus, protection switching is performed at the inter-

faces to the cross-connect switch and not in the switching matrix. Pre-determined connections in the switching matrix may be maintained regardless of which one of the inbound working and protection channels are selected to be provided to the switching matrix.

[0005] The present invention provides various technical advantages over conventional protection switch techniques. For example, one technical advantage is to avoid adjusting connections in a matrix of a cross-connect switch to effect a protection switch. Another technical advantage is to provide a capability to effect protection switches in a cross-connect switch at its input/output interfaces rather than its matrix. Yet another technical advantage is to provide a simpler protection switch technique for any protection scheme implementation. Other technical advantages may be readily apparent to those skilled in the art from the following figures, description, and claims.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0006] For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following description taken in conjunction with the accompanying drawings, wherein like reference numerals represent like parts, in which:

FIGURE 1 illustrates a protection switch for a 1+1 linear automatic protection switching protection scheme;

FIGURE 2 illustrates a protection switch for a 1:n linear automatic protection switching protection scheme;

FIGURES 3A and 3B illustrate a protection span switch for a bidirectional line switched ring protection scheme;

FIGURES 4A and 4B illustrate a protection ring switch for a bidirectional line switched ring protection scheme;

FIGURE 5 illustrates a protection switch for a fast facility protection scheme.

### DETAILED DESCRIPTION OF THE INVENTION

[0007] FIGURE 1 shows a portion of two cross-connect switches in a telecommunications system 10. FIGURE 1 illustrates an example of a 1+1 linear automatic protection switching protection scheme. Telecommunications system 10 includes a first cross-connect switch 12 at a node A and a second cross-connect switch 14 at a node B. First cross-connect switch 12 includes a switching matrix 16, an output interface 18, and an input interface (not shown). Second cross-connect switch 14 includes an input interface 20, a switching matrix 22, and an output interface (not shown). The input interface for first cross-connect switch 12 may be similar to input interface 20 of second cross-connect switch 14. Also, the output interface of second cross-connect switch 14 may

be similar to output interface 18 of first cross-connect matrix 12. Information is carried between nodes A and B over one or both of a working channel 24 and a protection channel 26.

[0008] In operation, information is transferred over a matrix connection in switching matrix 16 to output interface 18. Switching matrix 16 may implement any type of switching scheme including a three stage non-blocking switching technique. Output interface 18 receives the information from switching matrix 16 at a bridge-selector 28. Bridge selector 28 places the information onto both working channel 24 and protection channel 26. Second cross-connect switch 14 receives working channel 24 and protection channel 26 at input interface 20. Input interface 20 includes a selector 30 that determines a signal quality of both working channel 24 and protection channel 26. Based on the signal qualities, selector 30 selects one of working channel 24 and protection channel 26. The selected one of working channel 24 and protection channel 26 is provided to switching matrix 22. Switching matrix 22 can maintain its pre-determined matrix connections regardless of which one of working channel 24 and protection channel 26 is selected. Thus, time consuming creation and deletion of matrix connections to accommodate a protection switch is avoided.

[0009] FIGURE 2 shows an example of a linear 1:n automatic protection switching protection scheme. In this example, n is 2 but may include any integer number. Switching matrix 16 of node A provides two information lines 32 to output interface 18. Selector 28 receives the two information lines and broadcasts the information over protection channel 26 and a plurality of working channels 24a and 24b in order to transfer the information. Selector 28 may also broadcast the information over protection channel 26 upon detecting a failure in any of working channels 24. At input interface 20 of node B, selector 30 receives protection channel 26 and the plurality of working-channels 24a and 24b. Selector 30 determines a signal quality of each of the plurality of working channels 24a and 24b. If a working channel fails, selector 30 signals 28 to place the failed channel on protection channel 26. Selector 30 selects the data of the failed channel from protection channel 26 and the plurality of the unfailed working channels, either 24a or 24b, onto information lines 34 for transport to switching matrix 22.

[0010] FIGURES 3A and 3B show an example of a bidirectional line switched ring protection scheme. FIGURE 3A shows a normal operation of the bidirectional line switched ring protection scheme where selector 28 provides information received from switching matrix 16 to working channel 24 and selector 30 switches the information on working channel 24 for transfer to switching matrix 22. Selector 30 checks the signal quality of working channel 24 and protection channel 26. FIGURE 3B shows operation during a span switch. For a span switch, selector 28 places information from switching

matrix 16 onto protection channel 26 in response to a request from selector 30. Selector 30 provides information from protection channel 26 to switching matrix 22. A span switch may occur whenever working channel 24 has poor or no signal quality.

[0011] FIGURES 4A and 4B show a ring switch in a bidirectional line switched ring protection scheme. FIGURE 4A shows a normal operation where selector 28 provides information to working channel 24 and protection channel 26 inbound to input interface 20 at node B. Input interface 20 also provides an outbound working channel 25 and an outbound protection channel 27. FIGURE 4B shows the events involved in a ring switch. Upon detection of a failure in the channels between node B and another node, selector 30 routes information on inbound working channel 24 to outbound protection channel 27. Selector 30 also routes information on inbound protection channel 26 to outbound working channel 25. The routing performed by selector 30 effects the ring switch without disrupting matrix connections within either switching matrix 22 or switching matrix 16.

[0012] FIGURE 5 shows a fast facility protection (FFP) scheme. The FFP scheme may occur within cross-connect switch 14. Cross-connect switch 14 receives working channel 24 and protection channel 26 at input interface 20. Selector 30a provides working channel 24 to switching matrix 22 and selector 30b provides protection channel 26 to switching matrix 22. Switching matrix 22 provides working channel 24 and protection channel 26 to an output interface 35. Output interface 35 includes a selector 37 that receives working channel 24 and protection channel 26 from switching matrix 22. Selector 37 checks a signal quality of both working channel 24 and protection channel 26 and accordingly selects one of working channel 24 and protection channel 26 for output.

[0013] All of the protection schemes discussed above provide for the occurrence of protection switching in the input and output interfaces of a cross-connect switch to avoid disruption of matrix connections in the switching matrix of the cross-connect switch. Thus, protection switching time requirements may be efficiently met without expending various resources necessary to perform a conventional protection switching operation. Though certain protection schemes are described, other protection schemes may implement this protection switching technique, including unidirectional path switched ring protection schemes.

[0014] Thus, it is apparent that there has been provided, in accordance with the present invention, a method and apparatus for providing network protection at input/output interfaces of a cross-connect switch that satisfy the advantages set forth above. Although the present invention has been described in detail, it should be understood that various changes, substitutions, and alterations may be readily ascertainable by those skilled in the art and may be made herein without departing from the spirit and scope of the present invention as defined

by the following claims.

# Claims

1. A method for providing network protection at input/output interfaces of a cross-connect switch, comprising:
  - receiving an inbound working channel and an inbound protection channel at an input interface;
  - determining a signal quality of the inbound working and protection channels;
  - selecting one of the inbound working and protection channels in response to the signal quality of the inbound working and protection channels;
  - providing the selected one of the inbound working and protection channels to a switching matrix.
2. The method of Claim 1, further comprising:
  - receiving a plurality of inbound working channels;
  - providing a protection switch request to an originator of the inbound working channels and inbound protection channel;
  - selecting two of the plurality of inbound working channels and the inbound protection channel;
  - providing traffic from the selected two of the plurality of inbound working channels and the protection channel.
3. The method of Claim 2, wherein the network protection is a 1:n linear APS protection scheme.
4. The method of Claim 1, further comprising:
  - providing an outbound working channel and an outbound protection channel;
  - switching the inbound working channel to the outbound protection channel;
  - switching the inbound protection channel to the outbound working channel, switching of the inbound working and protection channels preventing information from being provided to the switching matrix.
5. The method of Claim 4, wherein the network protection is a bidirectional line switched ring protection scheme implementing a ring switch.
6. The method of Claim 1, wherein the network protection is a 1+1 linear APS protection scheme.
7. The method of Claim 1, wherein the network protection is a bidirectional line switched ring protection scheme implementing a span switch.
8. The method of Claim 1, wherein the network protection is a FFP protection scheme.
9. The method of Claim 1, further comprising:
  - receiving a control signal, the control signal determining the selection of one of the inbound working and protection channels.
10. The method of Claim 1, further comprising:
  - maintaining connections in the switching matrix regardless of the selection of one of the inbound working and protection channels.
11. An apparatus for providing network protection at a cross-connect switch, comprising:
  - an input interface operable to receive an inbound working channel and an inbound protection channel, the input interface operable to determine a signal quality of each of the inbound working and protection channels, the input interface operable to select one of the inbound working and protection channels according to the determined signal qualities;
  - a switching matrix operable to receive a selected one of the inbound working and protection channels, the switching matrix operable to output the selected one of the inbound working and protection channels over a pre-determined matrix connection, the switching matrix maintaining matrix connections regardless of which one of the inbound working and protection channels is selected.
12. The apparatus of Claim 11, further comprising:
  - an output interface operable to receive the selected one of the inbound working and protection channels, the output interface operable to broadcast the selected one of the inbound working and protection channels onto an outbound working channel and an outbound protection channel.
13. The apparatus of Claim 11, wherein the input interface receives a plurality of inbound working channels, the input interface operable to select two of the inbound protection channel and plurality of inbound working channels.
14. The apparatus of Claim 11, further comprising:
  - an output interface operable to receive the selected one of the inbound working and protection channels, the output interface operable to select one of an outbound working channel and an outbound

protection channel over which the selected one of the inbound working and protection channels is to be carried.

15. The apparatus of Claim 11, wherein the input interface is operable to provide an outbound working channel and an outbound protection channel, the input interface operable to connect the inbound working channel to the outbound protection channel, the input interface operable to connect the inbound protection channel to the outbound working channel, thereby bypassing the switching matrix.

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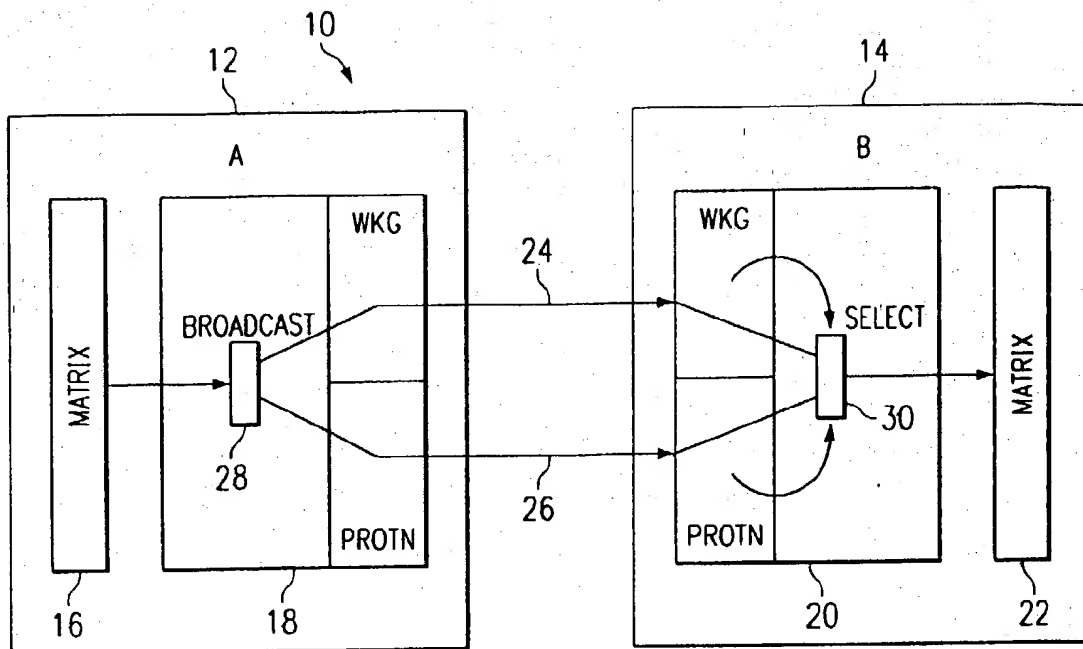


FIG. 1

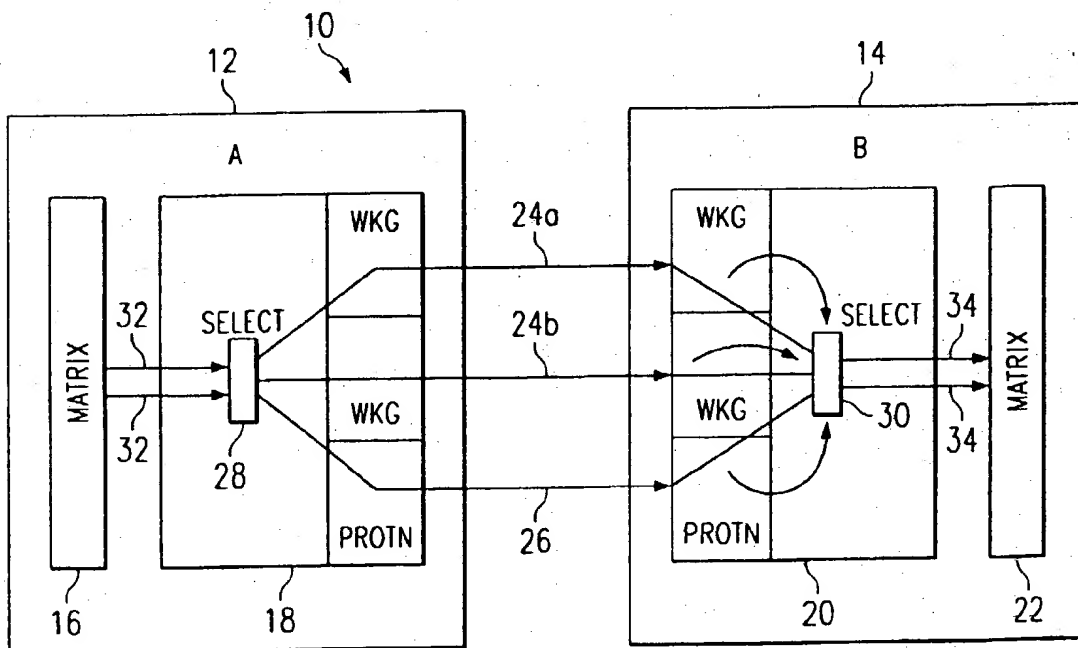


FIG. 2

FIG. 3

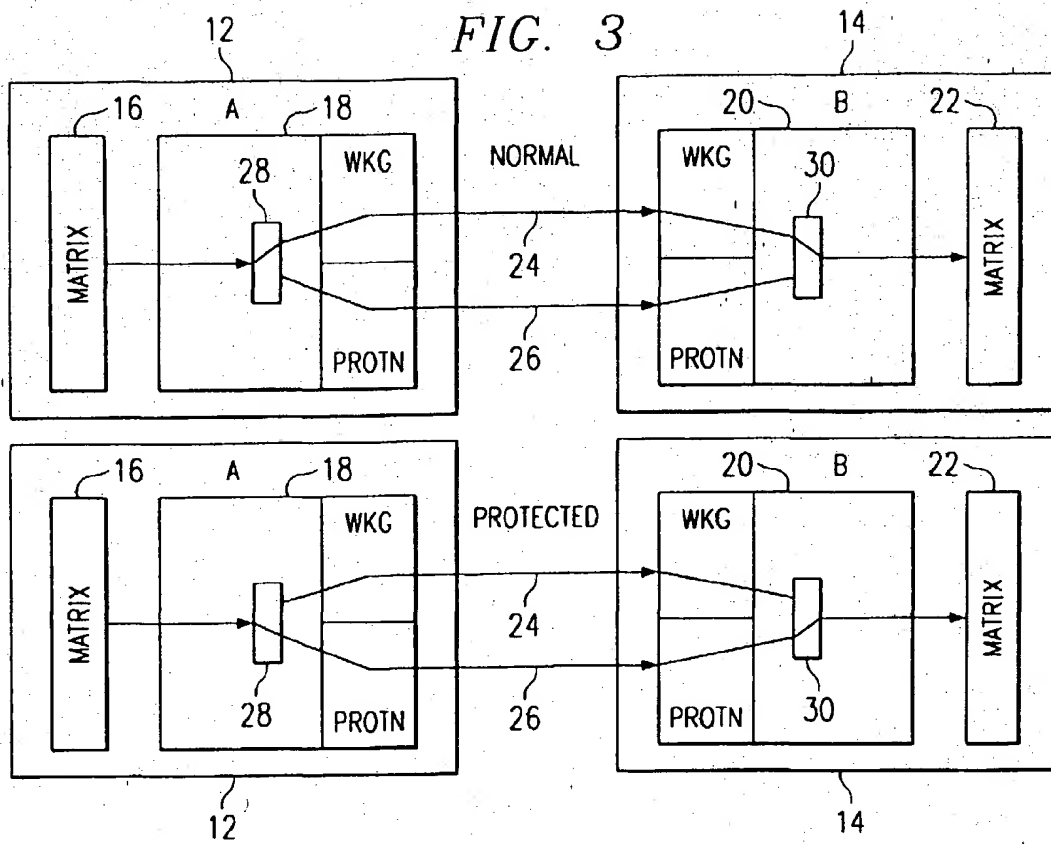
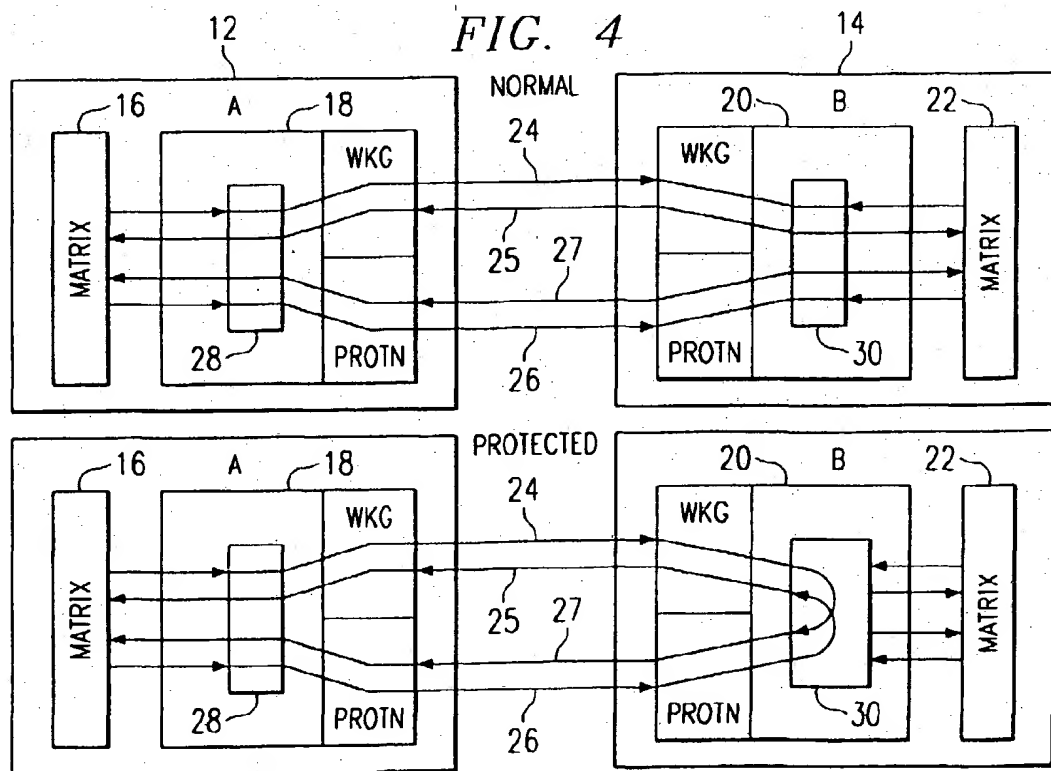


FIG. 4



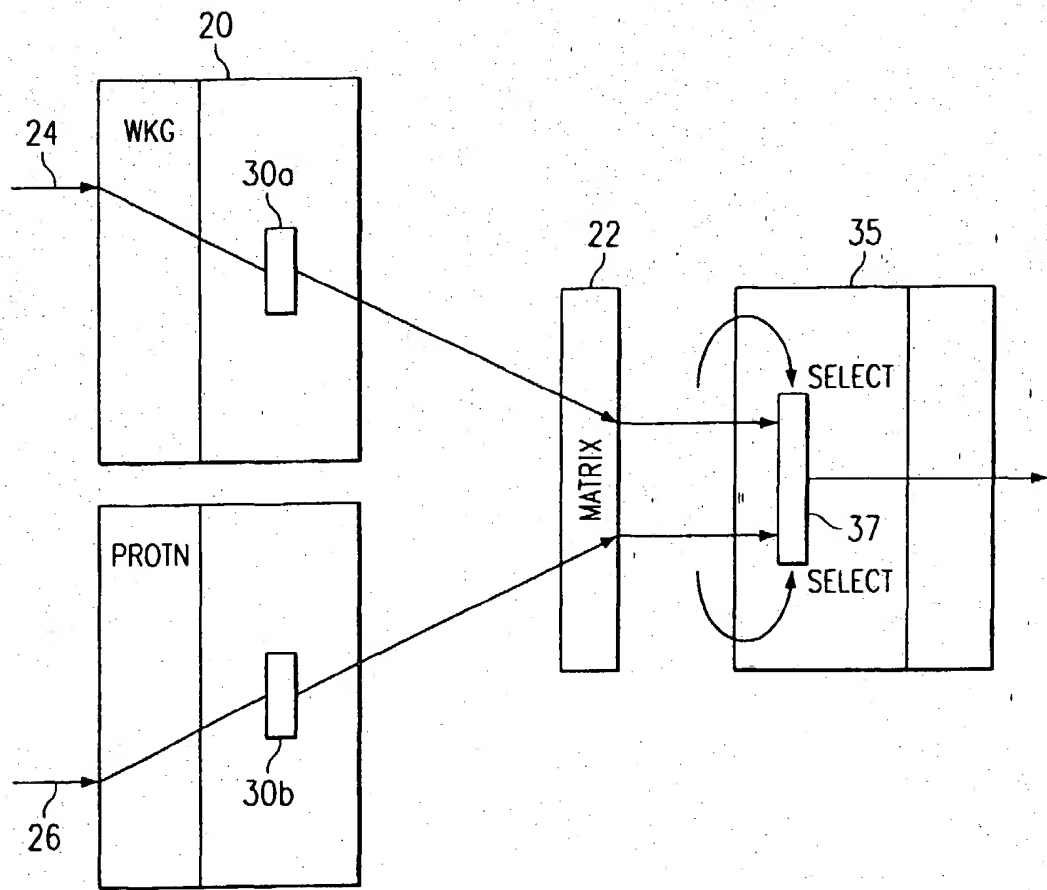


FIG. 5





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# EUROPEAN SEARCH REPORT

Application Number

EP 00 12 7125

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	EP 0 820 163 A (AT & T CORP) 21 January 1998 (1998-01-21) * abstract * * column 5, line 22-26 * * column 7, line 51 - column 10, line 12 * ---	1-15	H04Q11/04 H04J3/08 H04Q3/00
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A	EP 0 818 940 A (NORTHERN TELECOM LTD) 14 January 1998 (1998-01-14) * abstract * * page 8, line 17 - page 9, line 25 * * claims 5,6 * -----	1-15	<div> <p>TECHNICAL FIELDS SEARCHED (Int.Cl.7)</p> <p>H04Q H04J</p> </div>
The present search report has been drawn up for all claims			
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>25 April 2001</b>	Examiner <b>Gijssels, W</b>
<div> <p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons S : member of the same patent family, corresponding document</p> </div>			

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
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